UIC 3311

Region 8
9046

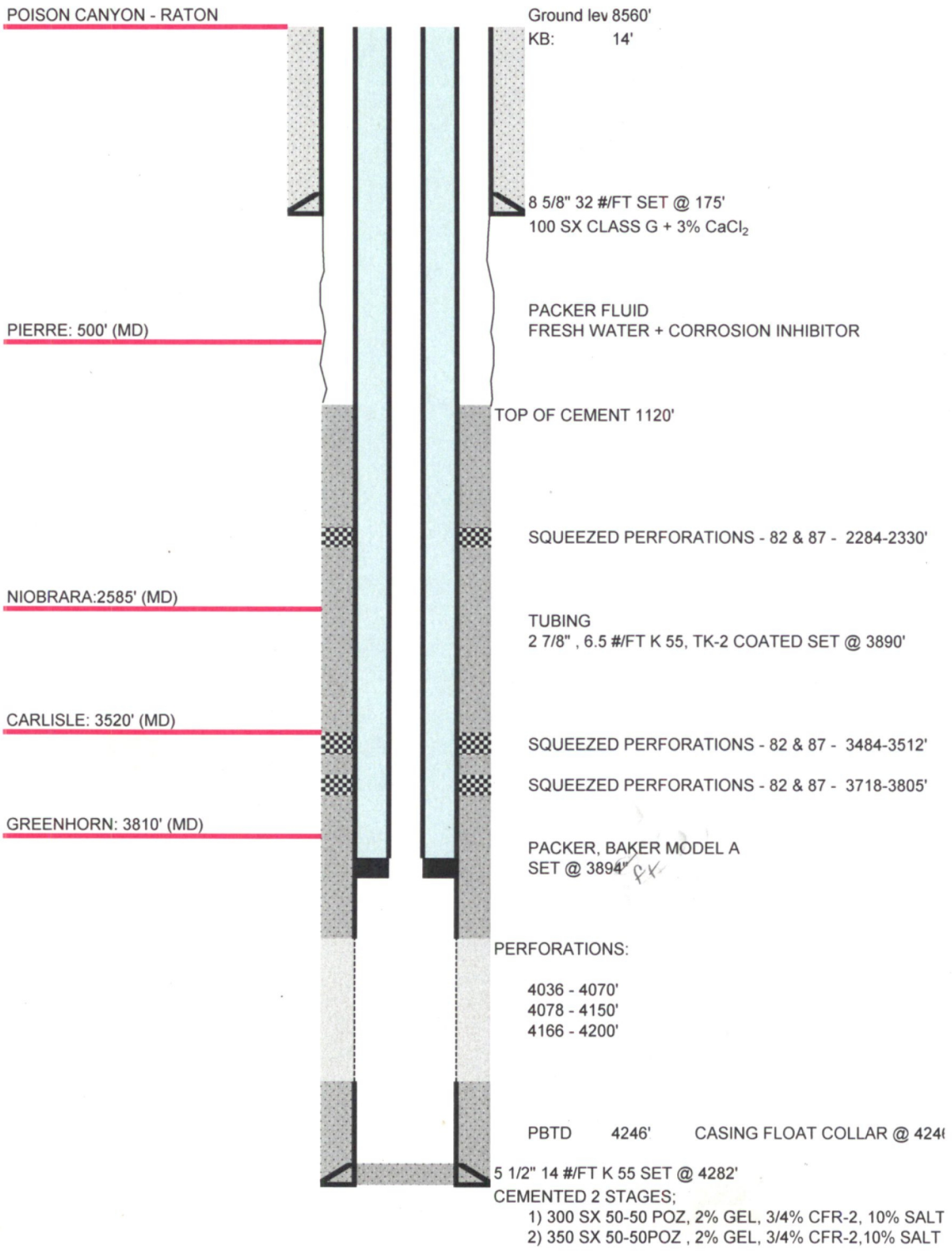
3 of 3

CO00055

204-079
205a(1) U C - CO10044-00055 - PERMIT, NO
(3 OF 3) BP AMOCO-GARCIA #1
Fldr #: 9046
PRIV

FIGURE 18

WELLBORE:



(A)

APR 0 1 19??

205
3

FINAL GEOLOGICAL REPORT

Atlantic Richfield Company
Sheep Mountain Unit #1-16
980' FNL & 1430' FWL
Section 16 - Twn 27S - Rge 70W
Huerfano County, Colorado

Development Well

Elevation: 7968' Grd and 7978' KB

Total Depth: 6200' MD (6003 TVD) BHL: 743 North & 1001 East of Surface Location

Working Interest: 100%

Spud: 8-10-75 Completed: 10-18-75

Initial Potential: P & A

Casing Record: 8-5/8" @ 259' w/250 sx

FORMATIONS

	Depth	Sea Level Datum
Pierre (Cretaceous)	1480	+6498
Apache Creek	3692	+4286
Niobrara	4172	+3806
Ft. Hays	4809	+3169
Codell	4882	+3096
Greenhorn	5144	+2834
Graneros	5260	+2718
Dakota	5390 (5259 TVD)	+2588 (+2719 TVD)
Morrison (Jurassic)	5690	+2288
Ralston Creek	5924	+2054
Entrada	6042 (5861 TVD)	+1936 (+2117 TVD)
Sangre de Cristo (Penn.-Perm)	6180?	+1798?

LOGS AVAILABLE

Log	From	To
DIL	223	6190
FDC-CNL	4500	6184
Dipmeter & Direction Log	240	6089
Mud Log (Core Lab)	265	6200
Sample Log	250	6200

WELL CUTTINGS

From 260'	To 6200'	Stored in Company Storage - Denver Warehouse

OIL AND GAS SHOWS

Formation	From	To	Comments
Dakota	5437	5460	Fluorescence and cut.
Entrada	6093	6145	Very slight streaming cut.

CORES

None

DRILLSTEM OR WIRELINE TESTS

Formation	From	To	Recovery
Dakota	5400	5454	500' SGCM + 2500' HGCW. BHS: 3.3 CF CO_2 + 2000 cc water.

CO_2 TS 33 MCFPD dec. to tstm. 99.69% CO_2. IHP 2846#, IFP 146-316#, ISIP 2150#, 2nd FP 391-974#, 2nd SIP 2075#, FFP 1031-1369#, FSIP 2122#, FHP 2818#, BHT 158°.

GEOLOGICAL COMMENTS AND RECOMMENDATIONS

This well was proposed as the initial attempt to evaluate the potential of the CO_2 accumulation in the Sheep Mountain structure. At the present time two wells are capable of production from the Cretaceous Dakota, the Faris No. 1 (Section 15, T.27S.-R.70W.) and the Garcia No. 1 (Section 35, T.27S.-R.70W.). The Faris No. 1 is also capable of CO_2 production from the Jurassic Entrada and the Garcia No. 1 produced hydrocarbon gas at low rates from an igneous intrusion and from the Cretaceous Codell. The Hughes No. 1 (Section 5, T.27S.-R.70W.) penetrated the Dakota gas-water contact at about a +4000 feet. The Sheep Mountain No. 1-16 was an effort to define the productive limits in the area between the Hughes No. 1 and the Faris No. 1 located down dip enough to provide the maximum data about the position of the

GEOLOGICAL COMMENTS AND RECOMMENDATIONS (cont'd)

gas-water contact south of the Hughes No. 1. At the same time three other locations were proposed to help establish a reserve potential for this large structure. The No. 2 was also staked down dip on the west flank of the structure positioned between the Faris No. 1 and the Garcia No. 1. The No. 3 and No. 4 locations were proposed to evaluate the northeast and southeast flanks respectively.

The dip of the west flank of the structure in the area of the No. 1-16 was much greater than anticipated. Cretaceous Pierre outcrops on trend with the drill site and about 1/2 mile northwest and 3/4 mile southeast were believed to indicate the presence of a thin Tertiary cover at the proposed location and a depth to the Dakota of about 3450 feet. Instead, the Tertiary was 1480 feet thick and the top of the Dakota was at 5390 feet. The strata in the bottom of the hole is dipping about 45° southwest. A test of the top of the Dakota recovered 500' SGCM and 2500' HGCW. The bottom hole sampler contained 3.3 cubic feet CO_2 and 2000 cubic centimeters of water. The well flowed gas at a maximum rate of 33 MCFPD decreasing to zero at the end of the test and the gas was analyzed at 99.69% CO_2. The presence of the CO_2 might indicate that an accumulation of waterfree CO_2 is a short distance up dip. The sharp gas-water contact in the Hughes No. 1 is at about +4000 and the top of the Dakota in the No. 1-16 is at +2588 indicating the possibility of two vertically separated accumulations.

It is recommended that the proposed location of Sheep Mountain No. 2 in the northwest quarter of Section 27 be dropped. The present data indicates this well site would be structurally low similar to the No. 1-16. Utilizing the +4000 foot gas-water contact and the structural configuration supplied by the proposed seismic program, the potential limits of the accumulation should be approximated without drilling wells near the gas-water contact. It is recommended that subsequent wells on the west flank of this structure be drilled up near the edges of the igneous outcrops which form Sheep and Little Sheep Mountains.

Prepared by: Neil Edmisten

SHEEP MOUNTAIN #1

SAMPLE DESCRIPTION

FORT HAYS	
4822-4862	Limestone: White to light gray, in part mottled medium gray, fossil fragments (foraminifers Ip., Pecec., Ost.) possible silt in part, mottled part argillaceous, and with dark gray to black shale partings and with scattered fine calcareous veins. Glauconitic at 4850-62 limestone becoming light brown in part towards base. Limestone pyritic in part.
4862-4880	Shale: dark gray, soft, fissile, carbonaceous, mica, pyrite, noncalcareous, very slightly calcareous, Ip.
4880-4884	Limestone: light to dark amber brown, very fine to fine fragments, Ip, Pecec., arenaceous, rare mica, rare pyrite, in part with argillaceous streaks.
4884-4899	Shale: as above
CODELL	
4899-4932	Sandstone: white to light gray, salt and pepper, fine to very fine, angular to subangular, well sorted, well to fair cement, very slightly calcareous, abundant white clay cement, rare glauconitic, possible carbonaceous and black shale grains, light gray chert grains. No porosity, no shows.
Trip at 4959	No samples 4950-4990
4990-5000	Shale: dark gray blocky, small silt and stain.
5000-	Shale: dark gray, blocky to fissile, hard siliceous with increased shale, dark gray brown, very calcareous with specks light and dark, trace pyrite, trace limestone, trace quartz, sharp fragments.
5050-5165	Shale: dark gray brown as above.
5165-5300	Limestone: mottled dark to medium brown pelletal to medium gray dense lutite: white crystalline to tan with shale stringers as above. Trace fossil fragments (pelecypods).
5300	Shale: dark gray carboniferous, fissile, slightly calcareous, trace chalky limestone to mottled, trace bentonite.
5385-5412	Slight stain very fine grain sandstone: white, hard, nor porosity, quartzite appearance, slightly calcareous, trace chert, clear to smoky and shale as above.

Sheep Mountain #1 - Continued

DAKOTA	
5412-5415	Sandstone: conglomeritic, milky chert, some tripolitic, medium to very coarse, very poor sorting, hard (breaks across grains) siliceous, well cemented, subangular, no porosity, no shows.
5415-5437 ?	Sandstone: White, hard, well cemented, slightly calcareous, no porosity to trace, no show, poor to fair sorting, medium to coarse subangular to subrounded (dry sample).
5437-5446	Sandstone: white, medium stain, fair to good sorting, subangular to wubround, trace to fair porosity, possible very dull brown fluorescence, siliceous, well cemented, hard, fair cut in part.
5446-5460	Conglomeritic and sandstone as above. Cut as above.
5460-5540	Sandstone: clear, medium to coarse, hard, siliceous, subrounded to well rounded, poor sorting, fair porosity to good porosity, no stain, no fluorescence, no cut.
5540-5580	Sandstone and chert conglomeritic as above, interbedded.
5580-5640	Sandstone: medium to coarse, poor sorting, tan stain, slightly calcareous, trace to poor porosity, no fluorescence, no cut, hard, trace conglomeritic and sandstone as above.
5640-5684	Increasing in sandstone, no stain, very poor sorting, hard, white.
MORRISON	
5684-5694	Sandstone: white, medium to coarse, conglomeritic with gray and white angular chert fragments. In part translucent - chalcedonic bond with some round grains included.
5694-5740	Shale: green and shale green hard silty trace pyrite. Some red-brown slightly platy shale with trace sericite.
5740-5797	Shale: red and red-brown with green and light green layers. Trace white microcrystalline limestone with some sand grain inclusions.
5792-5816	Sandstone: white, fine, subangular, tite with white siliceous bond. No porosity, no shows, no fluorescence.
5816- 5880	Shale: red with green layers some white medium grain silica filled sandstone, some round clear grains.
5880-5900	Sandstone: white hard siliceous bond, angular to subangular, with gray and white chert with pyrite layers pale green to blue green, hard siliceous shale. Translucent pink very fine limestone and sandy limestone.

5900-5935 Sandstone: hard, tite. Chert fragments and pyrite includes increase in red hard shale and sandy shale.

5935-5965 Sandstone: white medium grain (clear rounded grains in opague white silica bond, few angular orange chert fragments) interbedded with pale blue green siliceous shale and red hard shale.

5965-5970 Limestone: gray to brown and tan micro crystalline.

5970-6025 Shale: gray soapy green and red. Some dark red ocassional thin limestone streak in part cream, pel., ost. Green shale has rare orange fine to coarse, angular chert fragments.

6025-6040 Sandstone: white fine to medium subangular, well bonded with silica, some pink and red grains, interbedded with moroon, pink and green shale.

NOTE: Mud contaminated from black magic from fishing job. Viscosity so high samples are poor.

6040-6062 Shale: Medium gray green, soapy, blocky, in part very fine arenaceous (clear to dark green to orange) with scattered fragments chert: orange, very fine to very coarse, angular.

ENTRADA
6062-6073 Sandstone: white to light gray, very fine to medium, subangular to subround, slightly calcareous, siliceous, few white to orange grains, rare-poor porosity, no shows, slight CO_2 detector show.

6073-6085 Shale: dark brick red, firm, blocky, silty, very fine arenaceous.

6085-6093 Limestone: light to medium gray to gray brown, dense, very fine arenaceous, argillaceous in part, pel and ost in part.

6093-6145 Sandstone: white, very fine to fine, subangular to subround, well sorted, fair cementing, in part calcareous, probably some clay cementing, poor to fair porosity, some good, no visible stain, very strong streaming cut in part.

6145-6190 Sandstone: as above, calcareous without porosity.

PERMO-PENN(?)
6190-6200 ? Shale: medium gray orange, dull, fissile, soft, arenaceous, in part lumpy appearing, possible cave.

CL1-12A (REV. 1964)

CHEMICAL & GEOLOGICAL LABORATORIES

P. O. Box 2794
Casper, Wyoming

WATER ANALYSIS REPORT

OPERATOR Atlantic Richfield Company
WELL NO. Sheep Mountain No. 1
FIELD Wildcat
COUNTY Hverfano
STATE Colorado

DATE October 8, 1975 LAB NO. 17736-2
LOCATION NE NW 16-27S-70W
FORMATION Dakota
INTERVAL 5400-5454
SAMPLE FROM DST No. 1 (Middle)

REMARKS & CONCLUSIONS: Clear water.

Cations	mg/l	meq/l
Sodium	9806	426.56
Potassium	204	5.22
Lithium		
Calcium	193	9.63
Magnesium	92	7.56
Iron	-	
Total Cations		448.97

Anions	mg/l	meq/l
Sulfate	2200	45.76
Chloride	7700	217.14
Carbonate	-	
Bicarbonate	11346	186.07
Hydroxide		
Hydrogen sulfide	-	
Total Anions		448.97

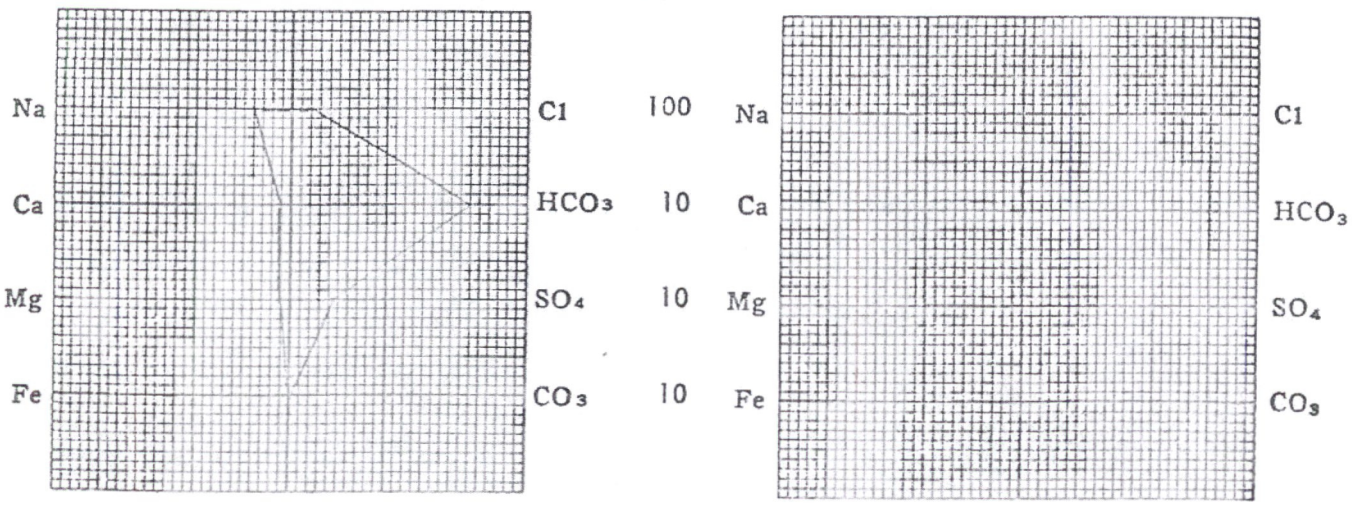
Total dissolved solids, mg/l 25783
NaCl equivalent, mg/l 22241
Observed pH 7.2

Specific resistance @ 68°F.:
Observed 0.34 ohm-meters
Calculated 0.32 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



(Na value in above graphs includes Na, K, and Li)
NOTE: Mg/l=Milligrams per liter Meq/l= Milligram equivalents per liter
Sodium chloride equivalent=by Dunlap & Hawthorne calculation from components

CL1-12A (REV. 1964)

CHEMICAL & GEOLOGICAL LABORATORIES

P. O. Box 2794
Casper, Wyoming

WATER ANALYSIS REPORT

OPERATOR Atlantic Richfield Company
WELL NO. Sheep Mountain No. 1
FIELD Wildcat
COUNTY Hverfano
STATE Colorado

DATE October 8, 1975 LAB NO. 17736-3
LOCATION NE NW 16-27S-70W
FORMATION Dakota
INTERVAL 5400-5454
SAMPLE FROM DST No. 1 (Bottom)

REMARKS & CONCLUSIONS: Clear water.

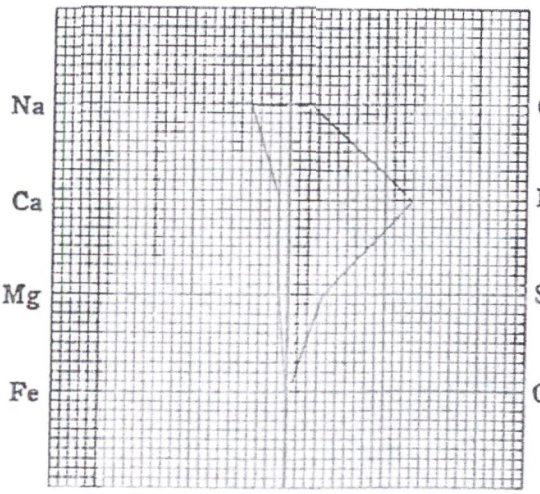
Cations	mg/1	meq/1	Anions	mg/1	meq/1
Sodium	8170	355.38	Sulfate	1700	35.36
Potassium	204	5.22	Chloride	7700	217.14
Lithium			Carbonate	-	
Calcium	240	11.98	Bicarbonate	7808	128.05
Magnesium	97	7.97	Hydroxide		
Iron	-		Hydrogen sulfide	-	
Total Cations		380.55	Total Anions		380.55

Total dissolved solids, mg/1 21956
NaCl equivalent, mg/1 19454
Observed pH 7.5

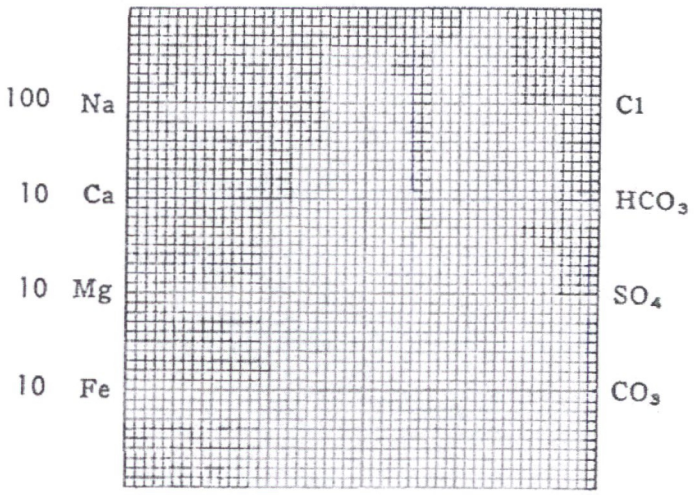
Specific resistance @ 68°F.:
Observed 0.34 ohm-meters
Calculated 0.36 ohm-meters

WATER ANALYSIS PATTERN

Sample above described



Scale
MEQ per Unit



(Na value in above graphs includes Na, K, and Li)
NOTE: Mg/1=Milligrams per liter Meq/1= Milligram equivalents per liter
Sodium chloride equivalent=by Dunlap & Hawthorne calculation from components

CL1-12A (REV. 1964)

CHEMICAL & GEOLOGICAL LABORATORIES

P. O. Box 2794
Casper, Wyoming

WATER ANALYSIS REPORT

OPERATOR Atlantic Richfield Company
WELL NO. Sheep Mountain No. 1
FIELD Wildcat
COUNTY Hverfano
STATE Colorado

DATE October 8, 1975 LAB NO. 17736-1
LOCATION NE NW 16-27S-70W
FORMATION Dakota
INTERVAL 5400-5454
SAMPLE FROM DST No. 1 (Top)

REMARKS & CONCLUSIONS: Muddy water.

Cations	mg/l	meq/l
Sodium	3532	153.64
Potassium	69	1.77
Lithium		
Calcium	99	4.94
Magnesium	29	2.38
Iron	-	
Total Cations		162.73

Anions	mg/l	meq/l
Sulfate	800	16.64
Chloride	2400	67.68
Carbonate	240	7.99
Bicarbonate	4294	70.42
Hydroxide		
Hydrogen sulfide	-	
Total Anions		162.73

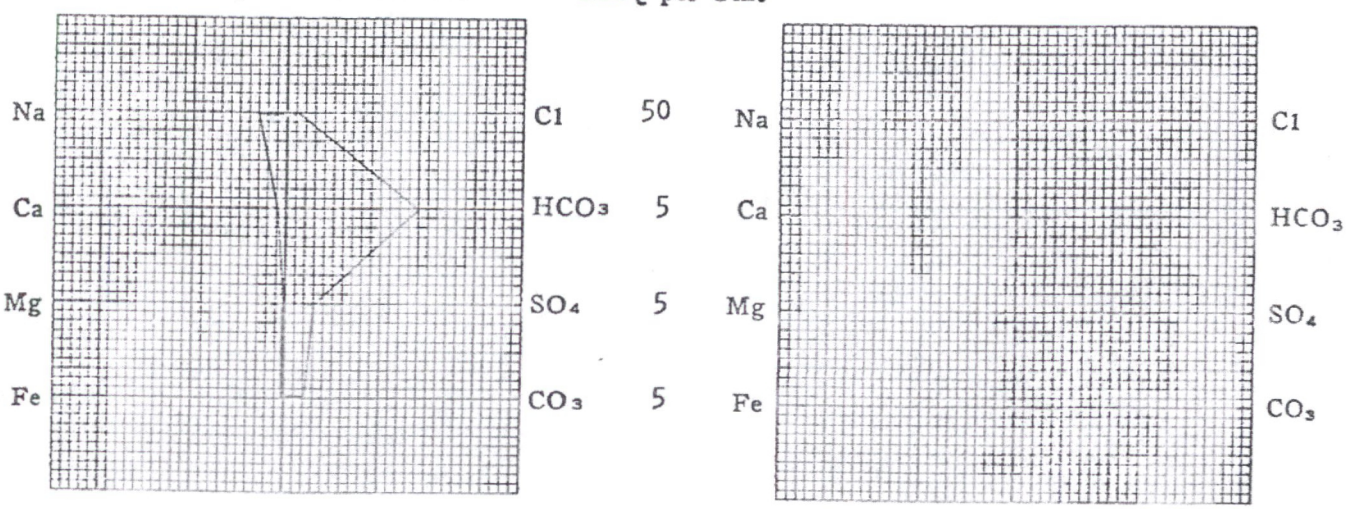
Total dissolved solids, mg/l	9284
NaCl equivalent, mg/l	8015
Observed pH	8.3

Specific resistance @ 68°F.:
Observed 0.84 ohm-meters
Calculated 0.84 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



(Na value in above graphs includes Na, K, and Li)
NOTE: Mg/l = Milligrams per liter Meq/l = Milligram equivalents per liter
Sodium chloride equivalent = by Dunlap & Hawthorne calculation from components

CL1-12A (REV. 1964)

CHEMICAL & GEOLOGICAL LABORATORIES

P. O. Box 2794
Casper, Wyoming

WATER ANALYSIS REPORT

OPERATOR	Atlantic Richfield Company	DATE	October 8, 1975 LAB NO. 17736-4
WELL NO.	Sheep Mountain No. 1	LOCATION	NE NW 16-27S-70W
FIELD	Wildcat	FORMATION	Dakota
COUNTY	Hverfano	INTERVAL	5400-5454
STATE	Colorado	SAMPLE FROM	DST No. 1 (Sampler)

REMARKS & CONCLUSIONS: Clear water.

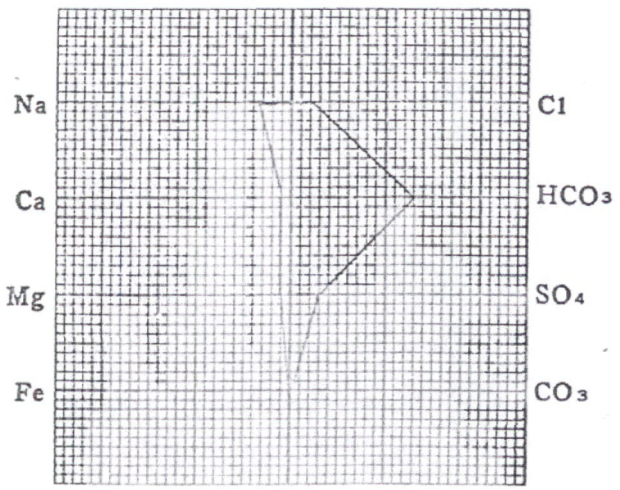
Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	8057	350.49	Sulfate	1650	34.32
Potassium	208	5.32	Chloride	7600	214.32
Lithium			Carbonate	-	
Calcium	254	12.67	Bicarbonate	7869	129.05
Magnesium	112	9.21	Hydroxide		
Iron	-		Hydrogen sulfide	-	
Total Cations		377.69	Total Anions		377.69

Total dissolved solids, mg/l	21756
NaCl equivalent, mg/l	19280
Observed pH	7.4

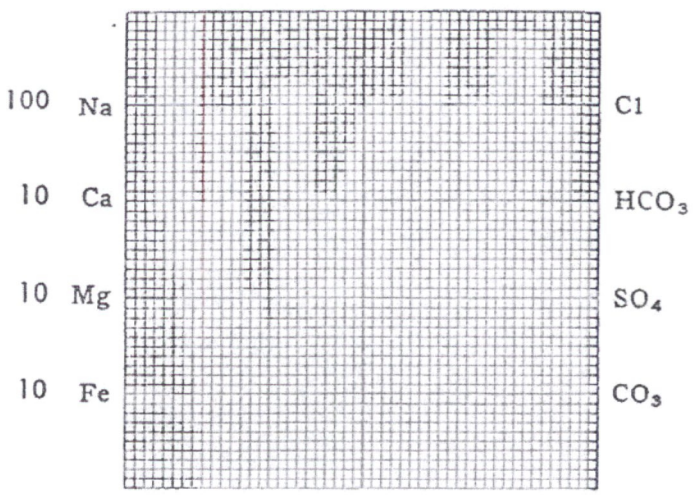
Specific resistance @ 68°F.:
Observed 0.35 ohm-meters
Calculated 0.36 ohm-meters

WATER ANALYSIS PATTERN

Sample above described



Scale
MEQ per Unit



(Na value in above graphs includes Na, K, and Li)
NOTE: Mg/l=Milligrams per liter Meq/l= Milligram equivalents per liter
Sodium chloride equivalent=by Dunlap & Hawthorne calculation from components

PETROPHYSICS

Petrophysical analyses were performed on 25 wells in the Sheep Mountain Unit and on 2 wells to the south in the Dike Mountain area. Where available, core data were utilized in the evaluation of these wells.

Wireline log information included dual-induction/gamma-ray and compensated neutron/formation density/gamma-ray logs. All wells except Sheep Mountain 13-1 were drilled with oil-based mud. The resistivity log run on the 13-1 well was a dual laterolog/gamma ray.

Values for porosity were estimated from the density logs of six wells for which core samples were retrieved from the Entrada Sandstone. These estimates compared favorably to porosity measured in the core samples taken from these wells. Therefore, density porosity was used for all other wells for which no core samples were taken. A matrix density of 2.66 grams per cubic centimeter, measured by special analysis of core samples, was used for log-calculated porosities for all wells. The availability of these special core analysis results significantly improved the reliability of the log-calculated values. Fluid densities of 0.95 and 1.1 grams per cubic centimeter were used in the porosity calculation for those wells drilled with oil-based mud and salt-based mud, respectively.

Water saturations were calculated using the standard Archie equation. The special core analyses referred to earlier were run on the Sheep Mountain 2-22-A and 7-9 wells and the Dike Mountain 4-13 well in the Entrada interval. These analyses provided actual measured values for the constants "a," "m," and "n" used in the log calculations. Once again, the availability of these laboratory-measured values significantly enhanced the reliability of the calculations and results discussed herein. A measured formation water salinity of 33,000 parts per million sodium chloride was used to calculate the formation water resistivity of 0.19 ohm-meters at 75 degrees Fahrenheit used in the calculations.

Net porous sand thickness was estimated using a minimum limit of 10-percent porosity and a maximum limit of 60-percent water saturation. These limits were established by analyzing the well-test results and the reservoir permeability and porosity data from core analyses shown on Figure 3, which is a cross-plot of core permeability versus core porosity for the six wells (7-9, 5-15-F, 2-22-A, 4-26-E, Dike Mountain 7-7, and Dike Mountain 4-13) cored

in the Entrada interval. For porosity less than 10 percent, Figure 3 indicates a narrow range of permeabilities below 0.5 millidarcy, with most points being less than 0.1 millidarcy. With porosity greater than 10 percent, the permeabilities of the core samples increase steeply, generally from 0.1 to more than 100 millidarcys. All net sand thickness estimates were corrected to true vertical net thickness by applying hole angle and apparent dip-correction factors.

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